

Evaluation of Highly Selective Activating Solution for the Fine Pattern Deposition

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Abstract

Recent years, the electronic devices are becoming smaller and more complicated sharply, since many electronic instruments are downsizing. As a result, L/S (lines and spaces) of circuit pattern and ULSI (ultra large scale integrated circuit) wiring formation trend toward minimal. Accordingly, in order to correspond to LSI and CSP packaging with higher densities, PCBs (printed circuit boards) of 50μm L/S or less have been developed [1,2].

Electroless nickel and immersion gold plating for the high density PCBs, BGA (ball grid alley) and CSP (chip scale package) manufacturing process are the key technology to obtain the connection reliability. In the case of electroless nickel plating using hypophosphite as a reducing agent, the palladium activation step is generally necessary for the initiation of electroless nikel deposition on copper, because metallic copper does not have catalytic activity to the hypophosphite ion [3].

However, as the space between the patterns has become narrow, bridges and/or outgrowths on circuit patterns are critical issue and the palladium activation step in the pretreatment is considered to cause extraneous deposition on insulator.

We have previously reported on the method of initating the plating reaction by the reducing agent without catalytic activity on copper [4,5,6].

However, catalyzing process using palladium catalyst is popular in manufacturing process.

In this examination, the composition of the palladium activating solution and the influence of the bath ingredients for the selective deposition of the electroless nickel plating were investigated.

The composition and conditions of palladium activating solution were shown in Table 1.

Experimental procedure is as follows. After performing the conventional preprocessing such as alkaline cleanings and acid activations, the palladium activation step was conducted and follows by the electroless nickel plating. Selectivity and surface morphology were observed with optical microscope and scanning electron microscope.

In preliminary survey, the suppression of the extraneous deposition was difficult by the changing Pd concentration.

Accordingly, effectiveness of complexing agent concerning termination of extraneous deposition was evaluated. The complexing agents composed by the typical ligand shown in Table 2 were used.As a result, selectivity of deposition was greatly different depending on the kind of the complexing agent.

Selectivity of deposition has been improved by adding ammonium chloride, ethylenediamine, and glycine within the range of 0.01-1mol/dm³.

In addition, In order to achieve high selectivity of deposition, the surfactants with different polarity were added.

The electroless nickel plating with excellent selectivity was formed for the fine pitch patterns by selecting the complexing agent and the surfactant appropriately as

shown in Fig.1.
These results will be explained in detail.

Palladium chloride	10~500mg/dm ³ (as Pd)
Conc.HCl	1cm ³ / dm ³
Disodium hydrogenphosphate	0.1 mol/dm ³
Additives	
(Surfactant, complexing agent)	
pH	2.5
(Adjusted by NaOH and HCl)	
Temperature	Room temperature
Immersion time	3min.

Table 1 Activating solution composition and operating condition.

Table 2 Various complexing agents for selectivity evaluation.

Ligand	Reagent	Ligand	Reagent
Hydroxyl group	Ethanol	Tertiary amine and Carboxyl group	NTA
	Glycerine		EDTA
Carboxyl group	Acetic acid	Ammonium	Ammonium sulfate
	Oxalic acid		Ammonium chloride
	Succinic acid		
Hydroxyl group and Carboxyl group	Glycolic acid	Sulfo group	Sodium sulfite
	DL-malic acid		Benzenesulfonic acid
	Citric acid		
Primary amine	Ethylenediamine	Oxime	Acetaldoxime
			Dimethylglyoxime
Primary, secondary amine	Triethylenetetramine	Heterocyclic amine	2,2'-Bipyridine
			Oxime
Primary amine and Carboxyl group (amine)	Glycine	Halide	Sodium chloride
			Sodium bromide
			Potassium iodide

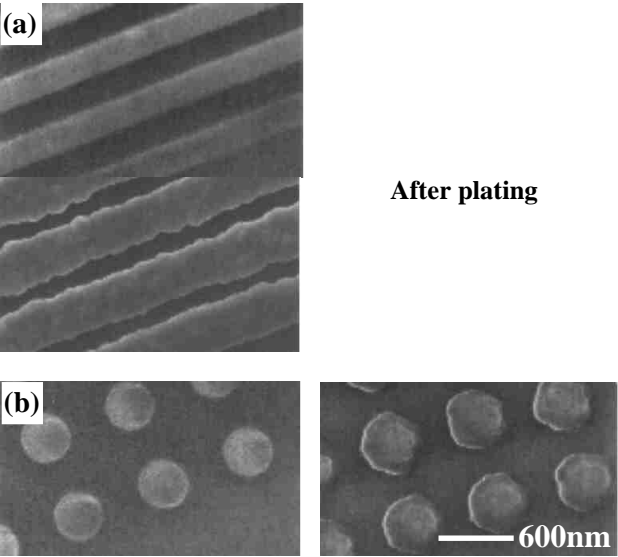


Fig.1 Top view FE-SEM images of electroless nickel deposits using selective Pd activating solution.
[Application to cap metal(ULSI) (a) Trenches (b) Via-holes]

Reference
1)S.Hotta,H.Takahashi, *Microelectronics symposium (Japan)*, **10**, P27 (2000)
2)N.Shimodo, K.Kikuchi, K.Matsui, Y.Shimada, *Microelectronics symposium(Japan)*, **10**, P31(2000)
3)D.W.Baudand ; *Plating and Surface Finishing*,Vol.68, No.12, p.50(1979)
4) H.Watanabe, Y.Igawashi, H.Honma, *J.Jap.Inst.Intercon.Pack.Electro.Circ.***12**,1,29(1997) (in Japanese)
5) H.Watanabe, Y.Igawashi, H.Honma, *J.Jap.Inst.Intercon.Pack.Electro.Circ.* **12**,4,231-235 (1997) (in Japanese)
6) H.Watanabe, H.Honma, **1998 IEMT/IMC Symposium, Proceedings, 149**(1998)